

Table of Contents

- **Acknowledgments**
- **About the principal authors**
 - Associate authors

PART 1: INTRODUCTION

- **Focus of this report**
- **Introduction to AM and 3D printing**
- **History of additive manufacturing**
 - 1960s to the modern era
 - April 2019 to March 2020
- **Industries, applications, and regions**
 - Industries
 - Applications
 - Installations by country
- **Medical applications**
 - Personalization of surgery using AM
 - AM for serial implant manufacturing
- **Dental applications**
 - Metal parts
 - Ceramic applications
 - Fixation devices
 - Metal castings
 - Drill guides
 - Dental models
 - Orthodontic aligners
 - Other developments
- **Applications in architecture and construction**

- Construction of full-scale buildings
- Using AM to produce individual parts
- Architectural models
- **Growth of CAD solid modeling**

PART 2: MATERIALS AND PROCESSES

- **Processes**
 - Material extrusion
 - Material jetting
 - Binder jetting
 - Sheet lamination
 - Vat photopolymerization
 - Powder bed fusion
 - Directed energy deposition
- **Materials**
 - Polymers
 - New polymer products
 - Polymer pricing
 - Metals
 - New metal powders and related developments
 - Making metal powders for AM
 - Water-atomized metal powders for AM
 - Pricing of metal powders
 - Composites and hybrid materials
 - Materials for metal-casting processes
 - Ceramics and other materials
- **Third-party Material Producers**
 - Open vs. Closed material business models
 - List of third-party producers

- **Process/material matrix**
- **Materials database**
 - Materials by process
 - Materials producers and products
 - Additional data

PART 3: INDUSTRY GROWTH

- **Revenue from AM worldwide**
 - Products and services
 - Growth percentages
- **System manufacturers**
 - Unit sales
 - Unit sales growth percentages
 - Market shares
 - Systems sold by region
 - Average selling price
 - Metal AM systems
 - Unit sales by manufacturer and year
- **Desktop 3D printers**
 - Growth
 - Average selling price
- **AM material sales**
 - Photopolymers
 - Polymer powders
 - Filaments
 - Metals
- **Investment in publicly traded companies**
 - Revenues and earnings
 - Outlook

- **Service providers**
 - Primary service market
 - Service provider survey
 - Contributing service providers
 - Survey results
 - Pre- and post-processing
 - Most popular AM technologies
 - Most profitable material
 - Revenue growth
 - Online marketplaces
 - Supplier competition
 - Comments from service providers

PART 4: FINAL PART PRODUCTION

- **Applications**
 - Aerospace
 - Medical and dental
 - Footwear
 - Motor vehicles
- **Benefits of AM for production**
 - Elimination of tooling
 - On-demand manufacturing and lead time reduction
 - Inventory reduction and part consolidation
 - Sustainability and waste reduction
 - Mass customization
 - Generative design and biomimicry
 - Optimized structures
- **Design for additive manufacturing**
 - Part consolidation

- Reduction of support material and post-processing
- Weight reduction and topology optimization
- Lattice structures
- Conformal cooling and improved fluid flow
- Cost benefits of DfAM
- **AM-related software**
 - Design and optimization
 - 3D scan-processing software
 - Repair
 - Simulation
 - Slicing and print preparation
 - Print management
 - MES
 - Security
- **Process monitoring in metal powder bed fusion**
 - Aconity3D
 - EOS
 - GE Additive
 - Renishaw
 - SLM Solutions
 - Sigma Labs
 - UTC
 - Velo3D
 - Outlook
- **Post-processing**
 - Post-processing of polymer parts
 - Surface treatment of polymer parts
 - Post-processing of metal parts
 - Thermal processing of metal parts

- Metal support material removal
- Metal surface treatment
- Metal part inspection
- **Challenges**
 - Running costs
 - Cost justification
 - Machine throughput
 - Metal part production cost considerations
 - Certification and quality assurance
 - Changing organizational culture
 - Educating designers

PART 5: GLOBAL REPORTS

- **Africa**
 - South Africa
- **Asia/Pacific**
 - China
 - India
 - Japan
 - Korea
 - Singapore
 - Taiwan
- **Australasia**
 - Australia
 - New Zealand
- **Europe**
 - Austria
 - Belgium
 - Denmark

- Finland
- France
- Germany
- Hungary
- Italy
- Netherlands
- Norway
- Poland
- Portugal
- Romania
- Russia
- Slovenia
- Spain
- Sweden
- Switzerland
- Turkey
- United Kingdom
- **Middle East**
 - Egypt
 - Iran
 - Israel
 - United Arab Emirates
- **Other regions**
 - Brazil
 - Canada

PART 6: RESEARCH AND DEVELOPMENT

- **Trends**
- **Patents**

- IP strategies
- Patent enforcement
- 3D-printed guns
- **Corporate R&D**
- **Consortia and collaborations**
 - America Makes
 - Additive Manufacturing Consortium
 - Direct Manufacturing Research Center
 - Project TEAMM
 - Partnerships
- **AM standards**
 - ASTM Committee F42
 - ISO/TC 261
- **AM Activities at NASA**
- **AM in the U.S. Department of Defense**
- **U.S. government-sponsored R&D**
 - National Science Foundation
 - Basic research on AM technology
 - DOD, DOE, and DOC
 - National Institutes of Health
- **U.S. national laboratories**
 - Oak Ridge National Laboratory
 - Lawrence Livermore National Laboratory
 - Sandia National Laboratories
- **Government-sponsored R&D in Europe**
- **Academic activities and capabilities**
 - AM educational activities
 - Research innovations
 - Asia/Pacific

- Europe
- North America
- Other regions
- Research institutes with AM capabilities
- Future trends and contributions

PART 7: THE FUTURE OF ADDITIVE MANUFACTURING

- **Emerging applications and industry trends**
 - Custom products for consumers
 - Development of metal AM
 - Adoption of AM in healthcare
 - Development of software tools for AM
- **Landscape of AM startups**
- **Startups and early-stage investments**
- **New AM machine developments**
- **Market opportunity and forecast**
 - Global manufacturing economy
 - Series manufacturing technology
- **Summary**

SYSTEM MANUFACTURERS

- **China**
 - Bright Laser Technologies
 - CTC
 - Eplus 3D
 - Farsoon
 - Huake 3D
 - Intamsys
 - Longyuan

- Raycham
- Tiertime
- TPM3D
- UnionTech
- ZRapid
- **Japan**
 - Aspect
 - CMET
 - D-MEC
 - Keyence
 - Matsuura
 - Mimaki
 - Ricoh
 - Sodick
- **Other companies in Asia/Pacific**
 - Asiga
 - Carima
 - InssTek
 - MicroJet Technology
 - ROKIT Healthcare
 - SPEE3D
 - XYZprinting
- **Germany**
 - Arburg
 - BigRep
 - Coherent
 - DMG Mori
 - Envisiontec
 - EOS

- German RepRap
- Nanoscribe
- Rapid Shape
- SLM Solutions
- Trumpf
- voxeljet
- **Other companies in Europe and the Middle East**
 - 3DCeram
 - Additive Industries
 - AddUp
 - Admatec
 - BeAM
 - Digital Metal
 - DWS
 - Hage3D
 - Lithoz
 - Massivit
 - Nano Dimension
 - Norsk Titanium
 - Prodways
 - Renishaw
 - Roboze
 - Sharebot
 - Sinterit
 - Sintratec
 - Sisma
 - Stratasys
 - XJet
- **U.S.**

- 3D Platform
- 3D Systems
- Carbon
- Cincinnati
- Desktop Metal
- ExOne
- Fabrisonic
- Formlabs
- GE Additive
- HP
- Markforged
- nScrypt
- Optomec
- Rize
- Sciaky
- Solidscape
- **Additional system manufacturers**
- **Manufacturer, process, and material matrix**
- **Desktop 3D printers**

APPENDICES

- **Appendix A: Glossary of terms**
- **Appendix B: 1988-2006 unit sales**
- **Appendix C: Metal AM comparison matrix**
- **Appendix D: 3D scanning systems**